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PORTABLE LASER LABORATORY

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Abstract. A Portable Laser Laboratory (PLL) is being designed and built for the CALIOPE Program tests which will begin in October of 1994. The PLL is designed to give maximum flexibility for evolving laser experiments and can be readily moved by loading it onto a standard truck trailer. The internal configuration for the October experiments will support a two line DIAL system running in the mid-IR. Brief descriptions of the laser and detection systems are included.

Introduction

The Lawrence Livermore National Laboratory (LLNL) has joined with other national laboratories in a program called CALIOPE to investigate the use of lasers for remote sensing. In order to be able to field these laser experiments at any of several locations and to permit laser configurations to change and evolve, LLNL decided to build a Portable Laser Laboratory (PLL) to be used during the tests for the CALIOPE program. The requirements for the PPL were that it be large enough to support many different types of laser/detector schemes and still be portable. We have deigned this unit and will take delivery in the first part of June of this year.

The PLL

The basic unit is a modular building with nominal dimensions of 12 x 12 x 44 feet. The unit is an all steel construction and was built by Atkinson Industries Inc. located in Pittsburgh, Kansas. It is insulated and air conditioned to prevent thermal problems with the laser systems. After delivery we will install a closed loop water cooling system to remove heat from power supplies and other heat sources in the trailer.

The main optical platform in the PLL is a 6 x 12 foot optical table in the center of the unit. The optical table is placed so there is a minimum of 30 inches clearance on all sides for easy access to the experimental set up. The optical table legs do not mount on the PLL floor but penetrate the floor through access holes and are mounted directly to the foundation pad on which the PLL is sitting. Mounted in this manner, the optical table has been isolated from mechanical vibrations in the PLL and pointing and viewing errors in the optical systems should be minimized.

Besides the optical table, the PLL includes areas for mechanical and electrical support activities so that maintenance and modifications can be handled in the field.

Electrical power is supplied to the PLL on three independent 240 volt, three phase, power feeds. One of these circuits will run the “dirty” equipment such as the air conditioner, vacuum pumps, and the water cooling and circulation. The second circuit will be reserved for “clean” power for running instruments such as the detector and the data storage system. The third circuit is a spare and will not be used initially.

Along one long side of the PLL we have arranged three shuttered windows which correspond to the ends and the center of the optical table. These will be the ports through which the laser is fired and the target is observed. We have also added access ports in the ceiling of the PLL in case we need to run a laser experiment vertically.

Laser System and Detector

For the October, 1994 tests, we will be using a two line DIAL system in the mid-infrared. The system will be tunable from about 3.2 µm to 3.7 µm but we will concentrate our experimental time on the HCl line at 3.6 µm (2775.76 cm^{-1}). The DIAL system will be a Non-Resonant Optical Parametric Oscillator (NR OPO) which will be pumped by a separate laser system. The pump will be a diode pumped YAG oscillator combined with a diode pumped amplifier. The output of the amplifier will be a 300 mJ, 20 ns pulse at 100 Hz.

The OPO will be seeded with two separate seed lasers simultaneously. The seed lasers are commercial units from Santec and are tunable from 1.3 µm to 1.55 µm. The seed lasers have a bandwidth less than 200 kHz and are stable for about 30 minutes.

The output of the OPO will be a 10 mJ, 10 ns pulse at 100 Hz in two separate lines separated by about 30 GHz. Beam conditioning optics will expand the diameter of this beam to about 5 cm and set the divergence to produce the best spot on the target. A sample of the output beam will be sent to the spectrometer to normalize the pulses measured in the return beam from the target.

The detector will consist of a light gathering telescope with a 10 inch diameter primary mirror and a focal length of 70 inches. The image of the target will be focused on the entrance slit of a spectrometer as will the sample beam from the output of the OPO. The spectrometer is capable of resolving wavelengths to 4 GHz so the 30 GHz separation between the two lines is more than adequate for our experiment.

By measuring the ratio of the on resonance and off resource lines (normalized by their respective output beams) we will be able to measure the concentration of the absorbing species (in this case HCl).

Conclusion

We have designed a Portable Laser Laboratory for use in the CALIOPE field tests and we are testing the components for the two line DIAL system that will be used in the October tests. The PLL is easily adaptable to many types of laser system configurations and can be moved on a truck to any appropriate test site.

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